Intelligent Companions for Older Adults

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ABSTRACT

Mobile technologies have the potential to enhance the lives of older adults, especially those who experience a decline in cognitive abilities. However, diminutive devices often perplex the aged and many HCI problems exist. This paper discusses the use of Artificial Intelligence (AI) techniques to develop intelligent algorithms which will (a) govern how a mobile application adapts the design of its multimodal interface to accommodate differing abilities of older users, and (b) intelligently compose and recount user life-cached memories in a multimodal storytelling format based on user abilities and preferences. A test-bed application entitled MemoryLane is currently being developed to implement these techniques.

Categories and Subject Descriptors

K.4.2. [**Social Issues**]: Assistive technologies for persons with disabilities.

General Terms

Algorithms, Design, Human Factors.

Keywords

Storytelling, Multimodal, Older Users, Usability, MemoryLane.

1. INTRODUCTION

The older population count is steadily increasing, especially in the more economically developed countries of the world [1]. It is well accepted that with age there is often an associated cognitive decline affecting abilities such as memory and planning. Cognitive decline is an inherent part of the natural ageing process ensuring that the numbers of sufferers increase steadily as the older population grows. Catering for such a diverse sector requires detailed analysis, active researchers within this area have highlighted the benefits of mobile devices to older adults and have emphasised the need to support designing for this genre [2]. Considerable research is also being conducted into developing systems which dynamically generate interfaces which adapt to a user's preferences or situation [4]. Assistive technologies exist which support older adults with memory impairment acting as reminder systems often liaising with carers [5]. However, in addition to developing memory prompts for current activities it is of equal importance to support older adults of this ilk in their pursuit of reminiscence. Reminiscence plays an important role in the lives of older people; many perfect the art of storytelling and enjoy its social benefits. The telling of stories of past events and experiences defines family identities and is an integral part of most cultures. Losing the ability to recollect past memories is not only disadvantageous, but can prove quite detrimental. Due to the known benefits of reminiscence among older adults, the objective of MemoryLane is to assist older adults in recalling their own past life events and memories as they experience the natural cognitive declines associated with the ageing process. MemoryLane is deployed on a Personal Digital Assistant (PDA) thus equipping users with the ability to re-live bygone days, and the portability to relay them to others. The research also addresses the usability problems encountered by older adults when using mobile devices.

2. SYSTEM DESIGN

System design follows the User Sensitive Inclusive Design (USID) methodology [3] and utilises the findings of two previously conducted ethnographic field studies. The first study investigated current PDA usability among older adults and concluded that participants found a basic PDA neither instinctive nor intuitive. The second study employed informal focus groups to elicit oral histories and investigate the reminiscence capabilities, patterns and preferences of older adults. The development process is iterative in nature, requiring repeated evaluations with an older adult sample. MemoryLane incorporates the AI techniques Case-Based Reasoning (CBR) and Rule-Based Reasoning (RBR) for its decision making in as depicted in Figure 1. The Artificial Intelligence (AI) aspects of this research are twofold. Firstly, MemoryLane is intelligently aware of its user's abilities and adapts its multimodal interface design upon this basis, thus compensating for a deficiency in a certain user modality, for example a visually impaired user would be compensated with an audio enriched interface. Secondly, MemoryLane intelligently compiles dynamic 'memory stories' for its user based upon its knowledge of that user's preferences at that point in time, for example a current story may choose to exclude a particular topic which could cause discomfort to its user or indeed highlight a more positive event. It is also vital that stories are constructed in an intelligent way, so that they (a) make sense, and (b) don't include erroneous data objects that do not belong to the history of the current user.

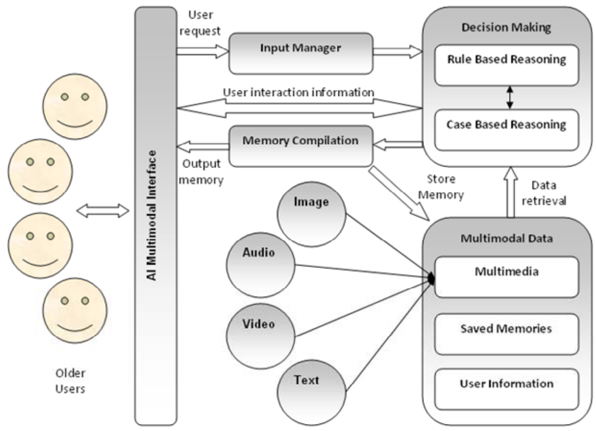

Figure 1. MemoryLane Architecture

2.1 System Architecture

The system operates across a local area network (LAN) client/server architecture as seen in Figure 2. The user's client PDA application connects to a server which provides system functionality through the interrogation of a back end MySQL database (storing user profiles and system information) via a web service. A Text To Speech (TTS) engine also based on the server facilitates the production of speech synthesis from string variables to support multimodal interaction.

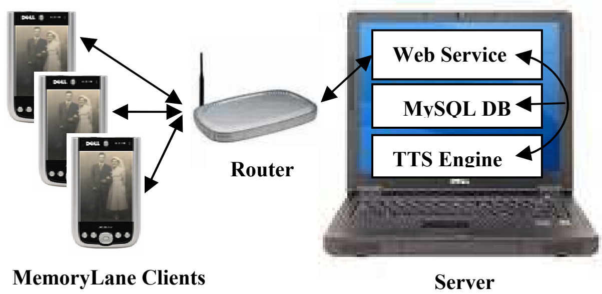

Figure 2. System Architecture

2.2 Intelligent Interface Design

A first time user is required to enter data to allow the system compile a unique user profile which is used both in the design of a personalised interface and in the compilation of life-cached data. Two rule bases employ intelligent algorithms to accomplish these aims. The first rule base is concerned with formatting the interface design. To accomplish this, the user is required to enter a rating for their perceived ability in four different modalities; Hearing, Vision, Speech and Dexterity. Users are asked to rate themselves as having Normal, Reduced or Very Poor levels of these abilities. The four ratings entered by the user are stored as part of that user's unique profile. The multimodal interface display will be designed based on the user profile as follows: The rating applied to Hearing will govern the amount of Audio Output (AO) used, the rating chosen for Vision will govern the style of the Visual Output (VO), the rating given to Speech will govern the amount of a Audio Input (AI) allowed for that user, and similarly the rating applied to Dexterity will govern the style and options that will be provided for Visual Input (VI). In turn, each audio/visual (A/V) input/output (I/O) aspect (AO, VO, AI and VI) also has three possible levels - 'Standard, Enhanced and Superior as seen in Table 1. Each alternative has a pre-set design configuration for formatting the specific interface components for which it is responsible. For example, AO affects audio and text-to-speech (TTS) synthesis levels, VO affects the size of on-screen text, images and video. AI decides when speech recognition is to be used and VI affects the size of all touch-screen buttons. In this way the system display can be adapted to suit the needs of many users, allowing for a possible 81 different permutations of interface design.

Table 1. Interface Formatting

User Modality Weighting	Multimodal Formatting			
	Output Display		Input Display	
	Hearing (AO)	Vision (VO)	Speech (AI)	Dexterity (VI)
Normal	Standard	Standard	Standard	Standard
Reduced	Enhanced	Enhanced	Enhanced	Enhanced
Very Poor	Superior	Superior	Superior	Superior

In a high level example; a user profile purporting very poor hearing, normal vision and speech with reduced dexterity (as depicted in the shaded cells of Table 1), would be provided with a tailored interface that would accommodate his/her needs. Superior AO would provide increased amounts of audio output at the default volume level (x 1.5) where TTS would be used to relay *all* on screen prompts aloud. Standard VO would display all on screen text, images, and video at a system default size. Standard AI would require minimal speech recognition, perhaps only prompting users for basic yes/no input, and Enhanced VI would ensure that all on screen buttons were at default button size (x 1.25) to compensate for poor dexterity. All default levels are based on results of prior usability studies.

3. CONCLUSION

This research addresses the AI techniques required to implement an intelligent companion for older adults and observes the effects of age on pervasive computing, and the HCI issues which must be addressed when developing mobile applications for older users.

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